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FOREST Pest LEAFLET

Black stain root disease

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Introduction

Black stain root disease, characterized by longitudinal dark stains (Fig. 1) in the root and butt wood of conifers, is caused by the native fungus *Leptographium wageneri* (Kendr.) Wingf. This condition is debilitating to the tree and frequently results in mortality. Although the fungus was collected in British Columbia in 1961, it was not reported causing disease until 1976. Subsequently, it has been reported from many areas in southern British Columbia, on the coast, and in the interior.

Hosts and distribution

The disease was first identified in California in 1938, when it was found to have killed ponderosa pine (*Pinus ponderosa* Laws.) (5). Subsequently, it was reported in Montana on eastern white pine (*P. strobus* L.) and lodgepole pine (*P. contorta* Loud. var. *latifolia* Engel.), and on several pine species in Colorado and California (4,5). Since 1971, when the disease was first reported in Washington and Oregon, it has been found with increasing frequency in Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco) plantations in the United States and British Columbia (5). In recent years it has been noted in spaced stands in particular (4).

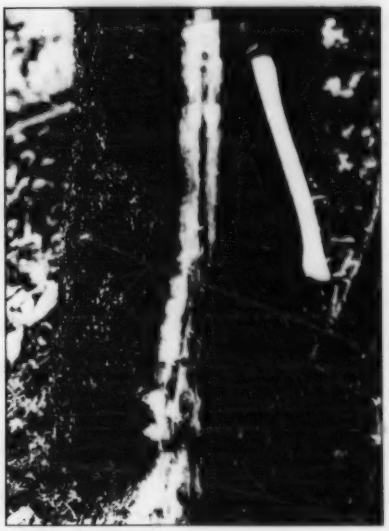

Fig. 1. Lodgepole pine with characteristic longitudinal dark stains of black stain root disease coming from the roots into the butt

In British Columbia, there are two pathotypes of the fungus. One, *L. wageneri* var. *pseudotsugae* Harr. et Cobb, is believed to be vectored by a host-specific, root-feeding beetle of the primary host, Douglas-fir. Other secondary hosts may be attacked if their roots contact infected roots of the primary host. However, based on two infected trees in British Columbia, western hemlock [*Tsuga heterophylla* (Raf.) Sarg.] is the only secondary host recorded to date. The other pathotype, *L. wageneri* var. *ponderosum* (Harr. et Cobb) Harr. et Cobb, is believed to be vectored by a different host-specific, root-feeding beetle of lodgepole pine, the primary host. In British Columbia, secondary hosts for this pathotype are spruce (*Picea* spp.) and western white pine (*Pinus monticola* D. Don). Elsewhere, this pathotype attacks ponderosa pine, western hemlock and mountain hemlock [*T. mertensiana* (Bong.) Carr.]. The distribution of both pathotypes is primarily in southern British Columbia. The Douglas-fir pathotype is found on the coast and in the interior (Fig. 2). The lodgepole pine pathotype is found only in the interior (Fig. 3). In parts of Europe (5) and eastern North America, a similar disease is attributed to *L. procera* Kendr. In British Columbia, *L. procera* has been recorded on Douglas-fir seedlings from a water-logged site. Also, in Europe, *L. serpens* (Goid.) Kendr. causes a black-staining root disease of pines (2,8).

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Damage in British Columbia

Leptographium wageneri has been found to cause mortality in 15- to 60-year-old Douglas-fir and 45- to 100-year-old lodgepole pine stands. As many as 30 Douglas-fir have been killed in patches (disease centers), and in some pine stands 50% or more of the trees have been affected in areas that may be as large as 350 ha (5,6).

Life history

The life history of black stain root disease needs to be documented further, especially in British Columbia. Once established in a tree, the fungus spreads from infected to healthy trees through root contacts or grafts (Fig. 4), thus producing a disease center in the stand. Weevils may also be responsible for tree-to-tree spread within disease centers (4,5). Some disease centers have increased radially as much as 4.5 m/yr in California (7), and about 2 m/yr in Oregon (5). The fungus grows through infected roots in the tracheids, passing from cell to cell at bordered pit-pairs. On reaching the root collar, it may extend a short distance up the bole and into uninfected roots. Extensive fungal growth in the xylem hinders water conduction, causing a vascular wilt. After tree death, the causal fungus probably stops spreading, and may die within dead roots (5).

This disease is spread over long distances by root-feeding beetles (4,5) that attack predisposed or injured trees. Trees growing in disturbed areas, such as road sides, land-fills, and clearcuts, are reportedly most susceptible to attack (5). However, in British Columbia, Douglas-fir with no apparent injuries or associated disturbances have also been infected, while old-growth lodgepole pine at high elevations are particularly susceptible (5,6).

Recognition

Crown symptoms (Figs. 5 and 6) produced by black stain root disease are similar to those caused by the root rot fungi *Phellinus weirii* (Murr.) Gilbertson or Armillaria root disease. Reduced leader and branch tip growth are followed by foliage discoloration and crown thinning. Douglas-fir, in particular, loses the inner, older foliage (Fig. 6). By the time advanced crown symptoms are evident, the purple-brown to black stain, characteristics of the fungus, is usually present in the main lateral roots, the root collar, and the lower bole. In the bole, the stain is usually limited to long tapered streaks (Fig. 1). The fungus is usually limited to the larger pitted spring wood, and travels from ring to ring through the rays. Cross-sections of infected boles reveal characteristic narrow bands of stain following the springwood in the annual rings (Fig. 7). In contrast, most sap stains are wedge-shaped and blue in color. *Atropellis piniphila* (Weir) Lohm. & Cash, which attacks hard pines, may produce a similar pattern and stain; however, it decreases outward from flattened, resin-soaked stem cankers, rather than from the roots. Occasionally, vigorously growing Douglas-fir may recover from infection.

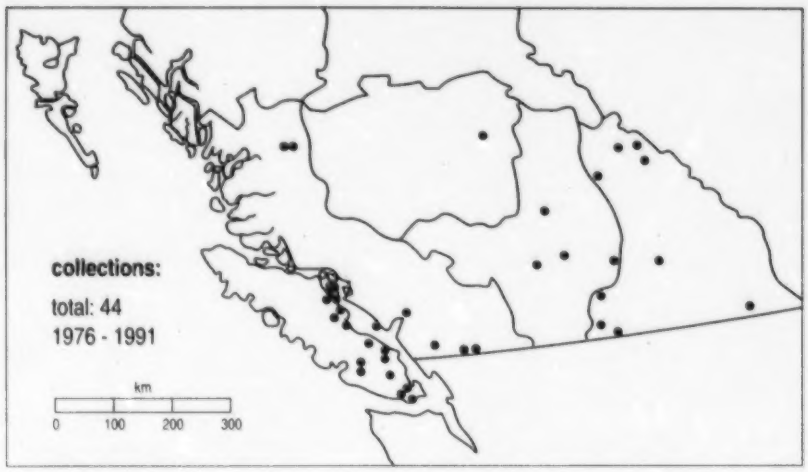

Fig. 2. Distribution of *Leptographium wageneri* var. *pseudotsugae*, whose primary host is Douglas-fir

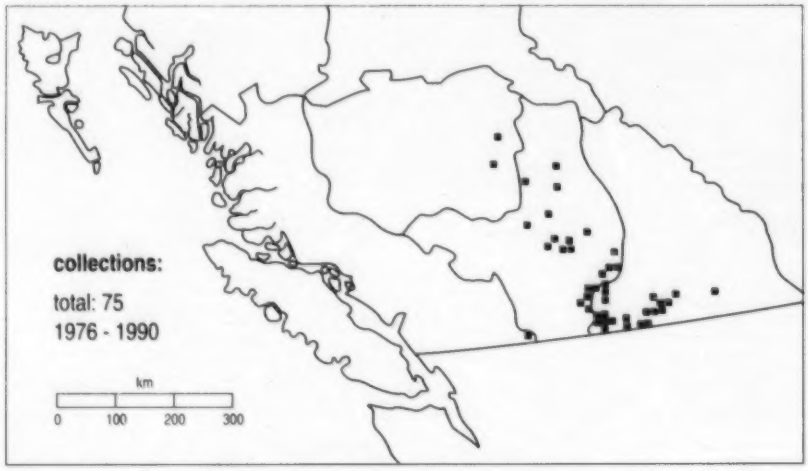

Fig. 3. Distribution of *Leptographium wageneri* var. *ponderosum*, whose primary host in British Columbia is lodgepole pine

Black stain root disease may weaken trees so that they become predisposed to attack by *Armillaria ostoyae* (a fungus that causes root disease) or bark beetles and are killed (5). In lodgepole pine, black stain root disease can maintain low levels of *Dendroctonus ponderosae* (Hopkins) and frequently causes epidemics of

Ips spp. (6). Therefore, careful examination of disease and bark beetle centers is necessary to determine the primary attacking agent. In dead trees, the typical stain may be obscured by secondary blue-stain and sap-rot fungi. The lower bole and roots of several trees bearing crown symptoms should be examined to confirm black stain root disease.

Control

During road construction or maintenance, care should be taken to minimize tree disturbance and damage, particularly in lodgepole pine and young Douglas-fir stands. All damaged trees at roadsides should be removed, or, as an alternative, a buffer strip could be cleared on either side of the road.

Stumps created during spacing or commercial thinning operations can attract insects that vector black stain root disease (4). As a result, insects can feed on roots of the remaining trees, thus initiating new disease centers. Apparently, there is no choice of season for spacing that minimizes the attraction of vectors to Douglas-fir stumps (5), while this has yet to be investigated for lodgepole pine. Expansion of disease centres in immature stands may be limited by felling infected trees, and by creating a surrounding 16- to 20-m buffer strip (5,7).

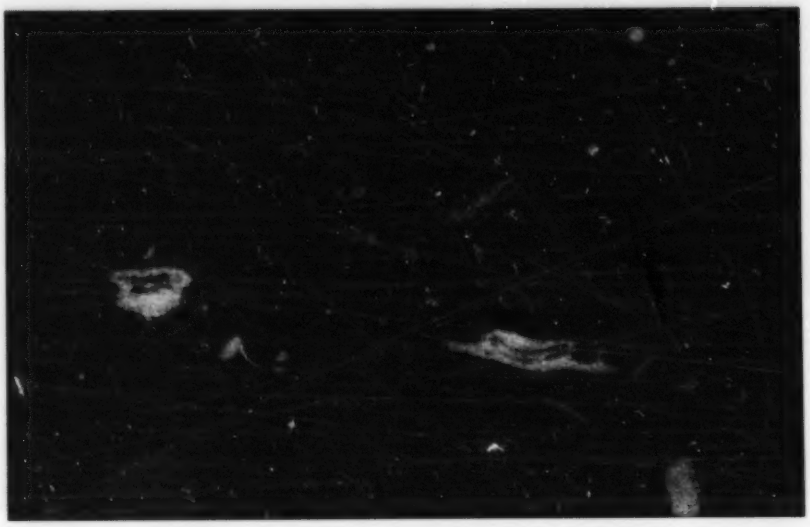

Fig. 4. Black stain root disease may spread from one tree to another through root contacts or grafts

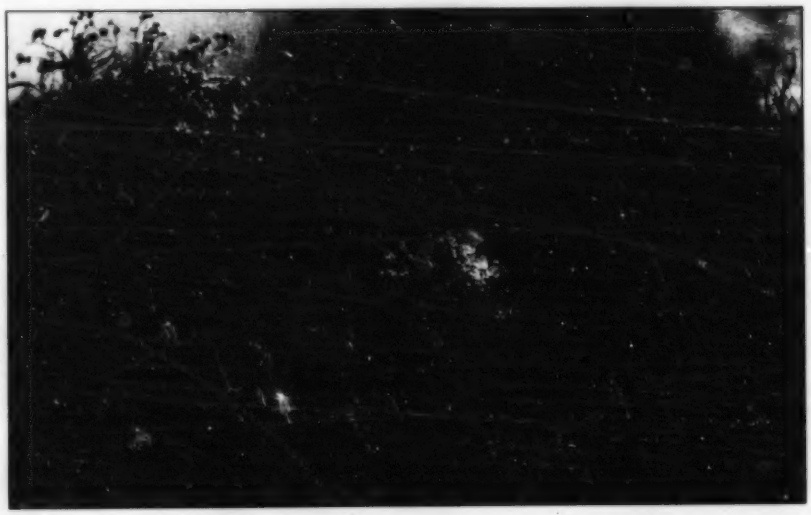

Fig. 5. Thinning and dying crowns of lodgepole pine are symptomatic of black stain root disease

Fig. 6. Casting of inner foliage and chlorosis of remaining foliage of Douglas-fir is symptomatic of black stain root disease

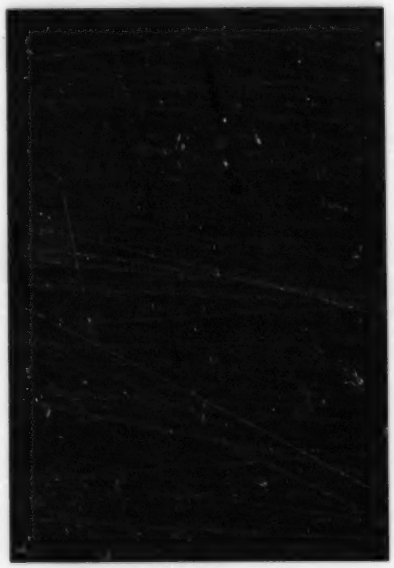

Fig. 7. Cross-section of a Douglas-fir shows banding pattern of stain, characteristic of black stain root disease

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Lodgepole pine stands above 1000 m in elevation and older than 80 years are very prone to infection, and should be scheduled for early harvest. Pine stumps are readily colonized by many fungi; consequently, *L. wageneri* loses out to better-adapted competitors, and is short-lived after harvest (6). Therefore, unlike other root diseases, clear-cut lodgepole pine can be immediately regenerated to lodgepole pine.

The survival of the fungus in spaced Douglas-fir stumps is considered to be of short duration, so these stumps are not considered important in the direct spread of the disease (5). Old-growth Douglas-fir stumps die over a protracted period of time, and would be expected, potentially, to attract vectors, or to harbour the fungus for many years. This would make them more important as initiators of new disease centers, but this has not been investigated. After about age 25, mortality in Douglas-fir caused by black stain root disease is rare. Vectors are probably attracted to trees weakened by other root diseases; consequently, the fungus is found in old-growth Douglas-fir in association with other root diseases.

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Additional Information

Further information may be obtained from:

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